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our reference	550GB
atent application number *(The Patent Office will fill in this part)*	0207298.1
ull name, address and postcode of the or of ach applicant *(underline all surnames)*	Renishaw plc New Mills Wotton-under-Edge Gloucestershire, GL12 8JR
'atents ADP number *(if you know it)*	2691002
f the applicant is a corporate body, give the :ountry/state of its incorporation	United Kingdom
'itle of the invention	Apparatus For Changing Operating Modules On A Coordinate Positioning Machine
Name of your agent *(if you have one)*	E C Leland et al
"Address for service" in the United Kingdom :o which all correspondence should be sent *(including the postcode)*	Renishaw plc, Patent Department New Mills Wotton-under-Edge Gloucestershire GL12 8JR
Patents ADP number *(if you know it)*	8187429001

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Description	8
Claim *(s)*	0
Abstract	0
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Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
Request for preliminary examination and search *(Patents Form 9/77)*	0
Request for substantive examination *(Patents Form 10/77)*	0
Any other documents *(please specify)*	0

11. I/We request the grant of a patent on the basis of this applicati

Signature E. Lelaw Date 27.03.20

AGENT FOR THE APPLICANT

12. Name and daytime telephone number of person to contact in the United Kingdom

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APPARATUS FOR CHANGING OPERATING MODULES ON A COORDINATE POSITIONING MACHINE.

This invention relates to apparatus for changing operating modules on a coordinate positioning machine. Co-ordinate positioning machines include, particularly but not specifically, co-ordinate measuring machines (CMM), machine tools and manual co-ordinate measuring arms.

Our earlier European patent 0566719 discloses a touch probe comprising a retaining module (such as a sensing module) and a task module (such as a stylus module). The task module is releasably mounted on the retaining module by magnetic means. A magazine comprising a plurality of storage ports is provided for the housing of task modules. The storage ports each comprise a base with a pair of jaws, the jaws having parallel docking inserts.

The probe may be mounted on the quill of a machine which transports the probe to the storage port into which the task module is inserted. The task module has a circular lip, the upper edge of abuts the lower surfaces of the docking inserts and which is held in place by magnetic attraction.

The task module is separated from the retaining module by upwards movement of the quill which, as the task module is retained by the storage port, breaks the contact between them.

Such a magazine and task modules enable engagement of a task module by a retaining module, and disengagement of

the task module from the storage port in a single continuous movement and without any additional machine apparatus (such as dedicated motors or electromagnets).

This method has the disadvantage that the magnetic force between the retaining module and the task module may be large and the force required to separate them will thus also be large. This is particularly so in the case of large probes where a large magnetic force is required in order to support a large and heavy task module.

The present invention provides a storage port for separating a magnetically coupled task module from a modular probe comprising:

a housing;

an arm rotatable about a pivot in the housing;

wherein said arm is receivable by a task module of the probe such that on moving the probe upwards, the task module is also pulled upwards, causing the arm and hence the task module to rotate about the pivot, and thus breaking contact between the task module and the rest of the probe with a tilting action.

This storage port thus allows a task module coupled to the probe by a strong magnetic force to be easily separated.

Preferably the arm has a U-shaped cut-out for receiving the task module. The U-shaped cut-out may be provided with sprung fingers to hold the task module in position on the arm. The sprung fingers may be integral with the arm.

Preferably a damper is provided to ensure smooth and controlled movement of the arm.

The damper may comprise a damping plate which is adjacent and substantially parallel to one of the arm and a surface of the housing and mounted on the other of the arm and the housing; wherein a viscous substance is provided between the damping plate and said one of the arm and a surface of the housing; such that on movement of the arm, the damping plate moves with respect to said one of the arm and a surface of the housing.

Alternatively, the damping may be provided by the pivot which is made from a flexible substance.

Preferred embodiments of the invention will now be described by way of example, with reference to the accompanying drawings wherein:

Fig 1 is a perspective view of a coordinate measuring machine carrying a probe;

Figs 2A and 2B are schematic views of the probe positioned in the storage port;

Fig 3A is a cross section through the storage port with a task module inserted;

Fig 3B is a cross section through the storage port with both the task module and retaining module inserted;

Fig 4 is a cross section through line A-A of Fig 3A;

Fig 5 is a plan view from above of the pivot arm in the storage port;

Figs 6 and 7 are cross sections through a second embodiment of the invention;

Figs 8 and 9 show the damper plate used in the second embodiment of the invention; and

Fig 10 is a cross section through a third embodiment of the invention.

Fig 1 shows a coordinate measuring machine (CMM) 10 in which a quill 12 may be moved in X,Y and Z by motors on the CMM (not shown). A probe 14 is mounted on the quill 12 and comprises a retaining module 16 which is attached to the quill 12 of the CMM and a task module 18 which is releasably mounted on the retaining module 16. The retaining module may comprise a sensing module which houses the sensing mechanism of the probe and the task module may comprise a stylus module. The position of the task module on the retaining module is defined by engagement between a set of kinematic elements on an upper surface of the task module with a set of kinematic elements on a lower surface of the retaining module. These kinematic elements may comprise, for example, three cylindrical rollers spaced at 120° about the longitudinal axis of the probe on one of the modules engageable with three pairs of balls similarly spaced on the other of the modules. The respective elements are held in engagement by the attraction between magnets provided on both the retaining and task modules.

The modular construction of the probe enables automatic exchange of styli and other task modules. To provide a truly flexible measuring system, a plurality of task modules must be retained within the working area of the machine to enable automatic exchange of one task module for another.

A storage port is provided on the CMM to house a task module. Several storage ports may be accommodated together in a magazine. A task module housed in a storage port may be picked up by the retaining module or a task module may be deposited into an empty storage port by the retaining module. In this manner the probe may exchange task modules so that it uses the most suitable one for the task in hand.

The storage port will now be described with reference to Figs 2-6.

A cross section of the storage port is shown in Figs 3A and 3B. The storage port 20 comprises a housing 22 with a pivot arm 24 located within the housing and extending out from the housing at one end. The pivot arm 24 is rotatable a limited amount about a pivot 26 located within the housing 22.

The part of the pivot arm 24 extending from the housing 22 has a U-shaped cut out 28 with two fingers 30 defining opposite sides, as shown in Fig 5. These fingers 30 of the pivot arm 24 are designed to receive the task module 18 of the probe. The task module is provided with a pair of recesses on its outer surface into which the fingers are inserted. Alternatively it may have, for example an annular recess to receive the fingers.

The task module 18 may thus be inserted into the storage port 20 by horizontal movement of the quill 12 and retaining module 16 on which it is secured.

Once the task module 18 has been inserted into the the

storage port 20, as shown in Fig 2A, the task module 18 may be separated from the retaining module 16 by moving the quill 12 and retaining module 16 upwards. As the task module 18 moves upwards, the end of the pivot arm 24 received by the task module 18 is also pulled upwards and rotates about its pivot 26. In doing so, it causes the task module 18 to likewise rotate and thus break contact with the retaining module 16 along one edge, as shown in Fig 2B.

As the rotating motion of the pivot arm 24 causes the retaining module 16 to break contact with one edge of the task module 18, rather than pulling the two modules apart along the longitudinal axis of the probe, less force is required in separating the two modules.

The storage port is shown in more detail in Figs 3-5. Fig 5 shows a plan view of the pivot arm 24 of the storage port. The U-shaped cut out 28 is provided with integral sprung fingers 32 to hold the task module in position. These sprung fingers 32 are deflected on inserting and removing the task module and once the task module is in position they are biased towards it, holding it in position.

As shown in Figs 4 and 5, the pivot arm 24 is rotatable about a pivot within the housing which comprises a spindle 34 which is attached to the housing 22 and pivot arm 24 respectively by countersunk screws 36. Other forms of pivot may be used.

It is desirable to provide damping for the rotatable pivot arm of the storage port to ensure that that the movement of the pivot arm is smooth and uncontrolled

shocks are eliminated. Damping is provided by a damping plate 38 shown in Figs 3A, 3B and 4. The damping plate 38 lies substantially parallel to the upper inside surface 40 of the housing 22 and is separated from this surface by a viscous substance, such as grease. The damping plate 38 is connected to the pivot arm 24 by a damper push rod 42. As the pivot arm 24 rotates about the pivot, the damping plate 38 is caused to move with respect to the inner surface 40 of the housing 22. The grease in between the two surfaces has a damping effect and ensures that the movement of the pivot arm 24 is smooth.

A spring 44 is provided on an inner surface of the housing 22 which pushes against the damping plate 38 to ensure that the damping plate 38 is retained close to the inner surface 40 of the housing 22.

The storage port 20 may be provided with a lid 46 as shown in Figs 3A and 3B. The lid is slidable between a first position shown in Fig 3A, in which it covers the part of the pivot arm 24 extending from the housing 22 and a second position shown in Fig 3B in which it is retracted inside the housing 22.

When a probe 14 is inserted into the storage port 20, the lid 46 is pushed into the housing 22 by the retaining module 16, as shown in Fig 3B. The lid is 46 biased so that once the retaining module 18 has been removed, it slides back into its first position covering the part of the pivot arm 24 extending from the housing 22 and thus protecting the task module 18.

Figs 6 and 7 illustrate a second embodiment of the

invention in which a different damping means is used. Similar parts to the first embodiment are identified by the same reference numbers. A damping plate 48 is provided within the housing 22 adjacent to the pivot arm 24 and with a viscous substance, such as grease, between them. The damping plate 48 is formed as shown in Fig 8 in which a plate 50 has an I-shaped cut out 52 forming two portions 54A,54B which may be folded into a perpendicular orientation with respect to the rest of the plate as shown in Fig 9. The damping plate 48 is attached by these perpendicular portions 54A,54B to a protrusion 56 from the upper inner surface of the housing 22 and is rotatable about this protrusion. On rotation of the pivot arm 24 about its pivot 26, the damping plate 48 is pushed in the direction shown by the arrow and pivots about its pivot 58, as shown in Fig 7. This movement against the pivot arm 24 has a damping effect. A spring (not shown) may be provided to keep the damping plate close to the pivot arm.

A third embodiment of the invention showing another damping means is shown in Fig 10. Again, similar parts to the first embodiment are identified by the same reference numbers. In this embodiment the pivot arm 24 rotates about a flexible pivot 60 which may be made from rubber or another suitable flexible substance. This flexible pivot 60 has the advantage that it also provides some damping. Additional damping may be provided by a separate damper 62, comprising for example a piston 64 attached to the housing 22 which is inserted into a reservoir 66 of grease mounted on the pivot arm. A spring 68 in the reservoir biases the pivot arm into its rest position.

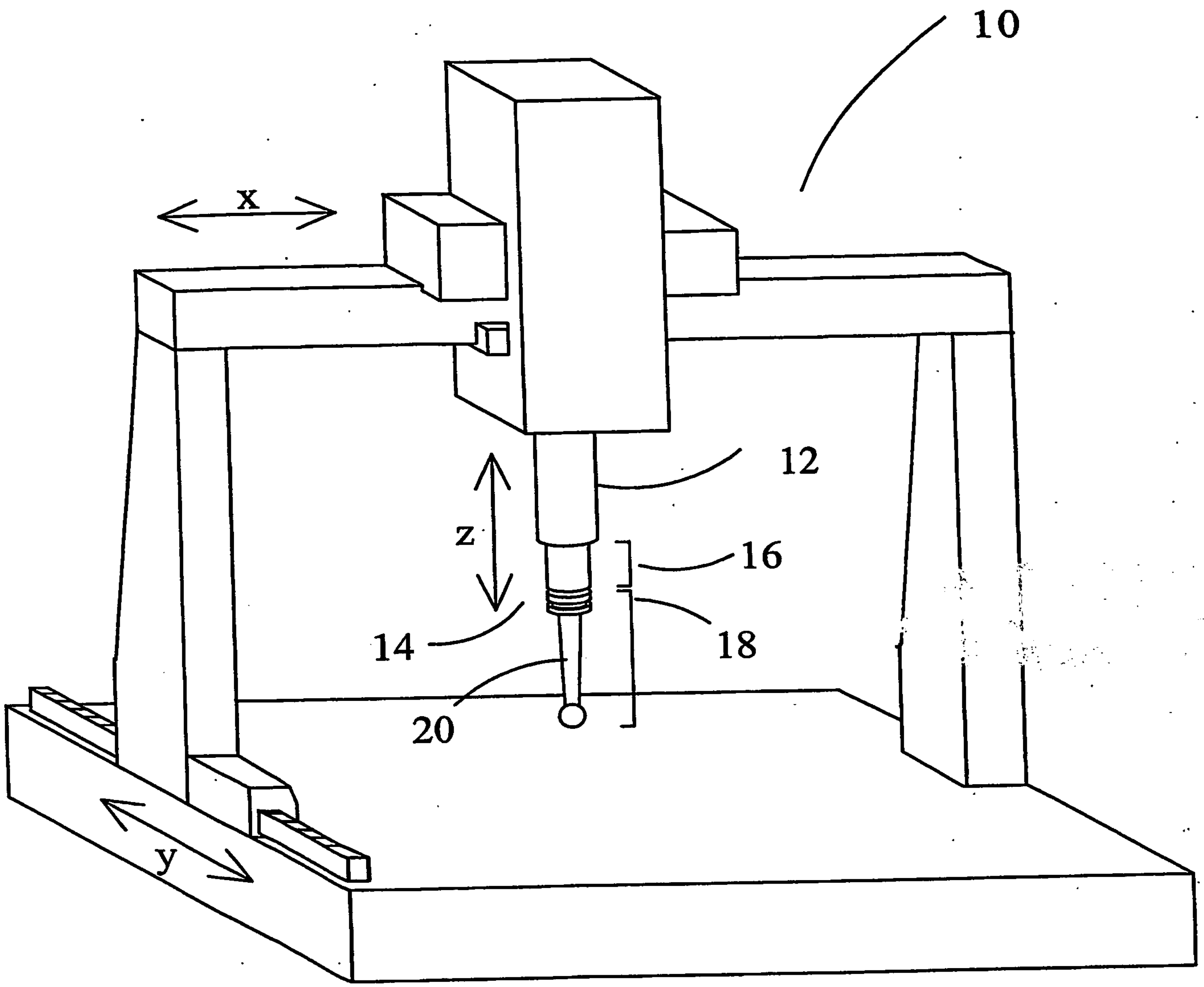

Fig 1

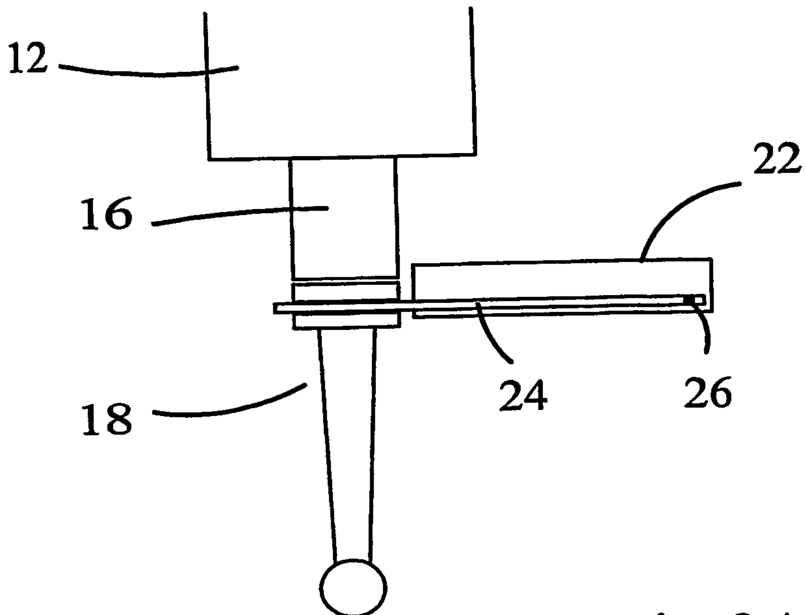

Fig 2A

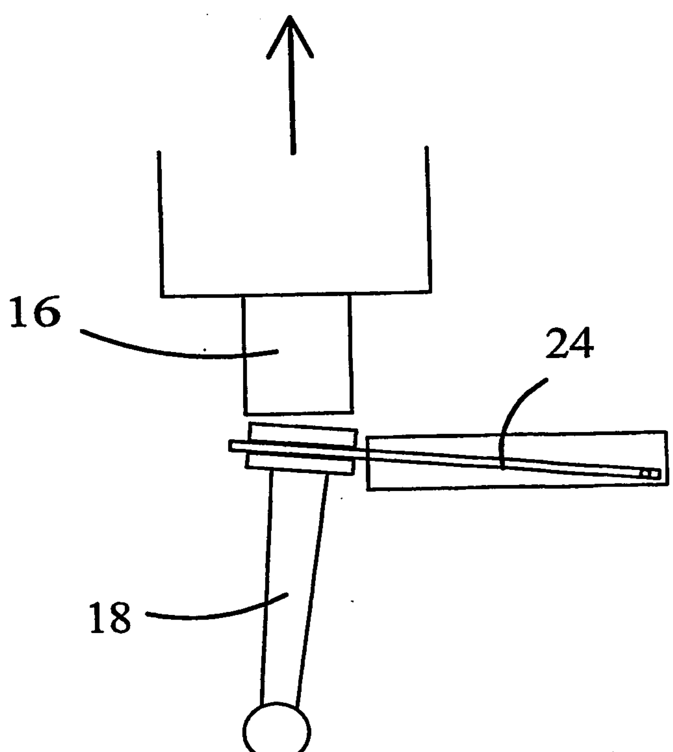

Fig 2B

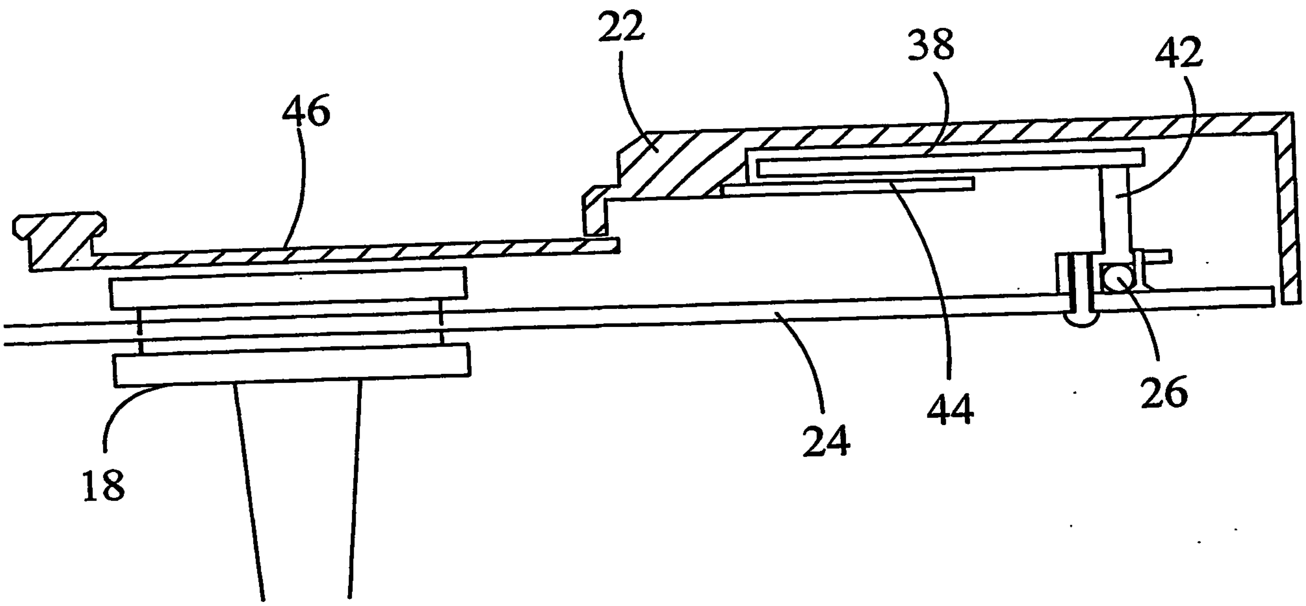

Fig 3A

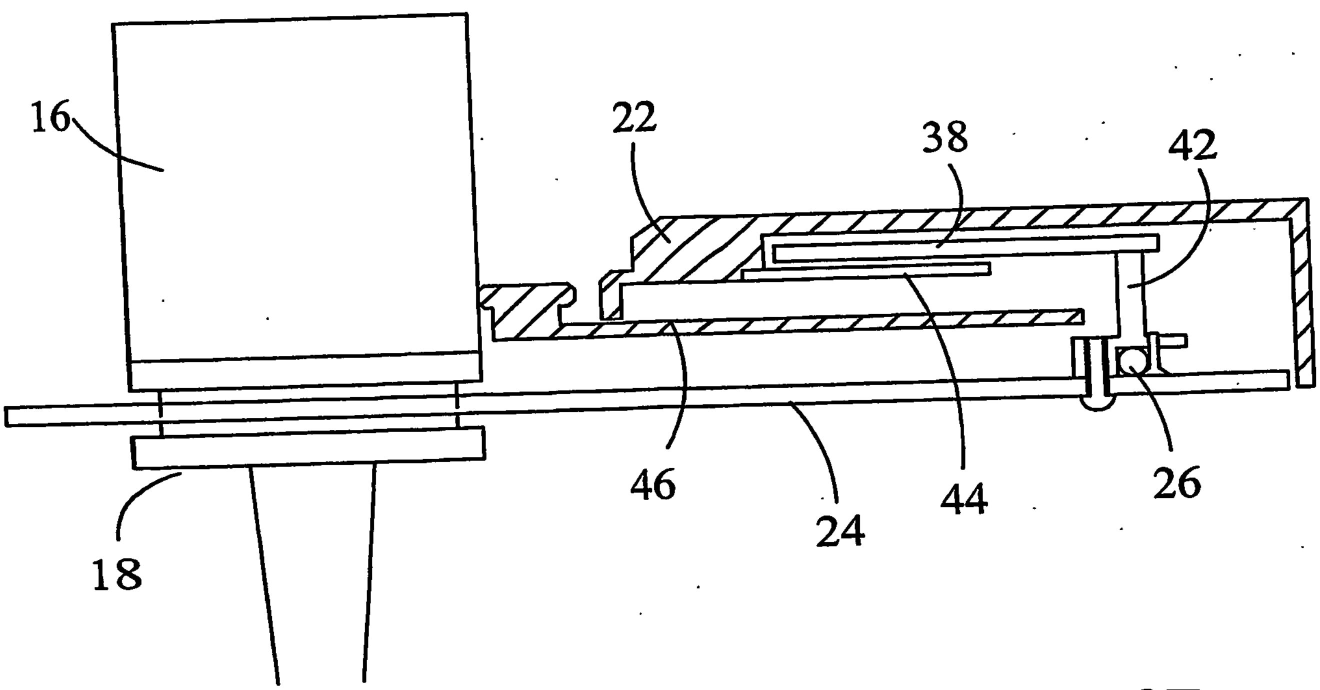

Fig 3B

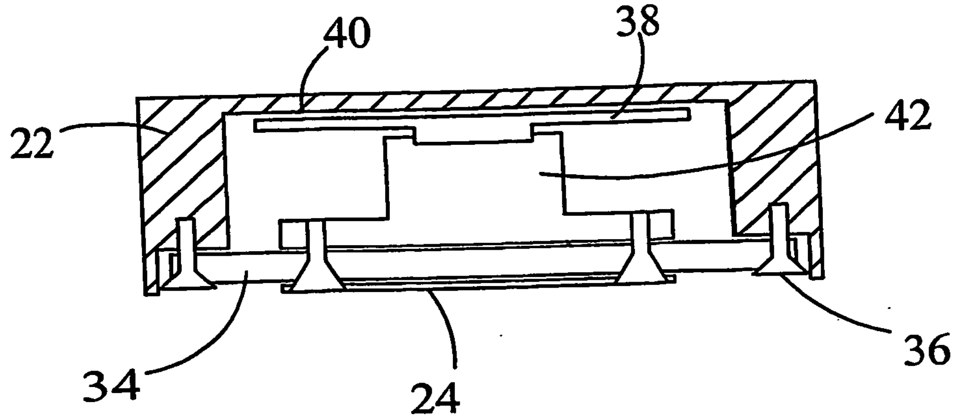

Fig 4

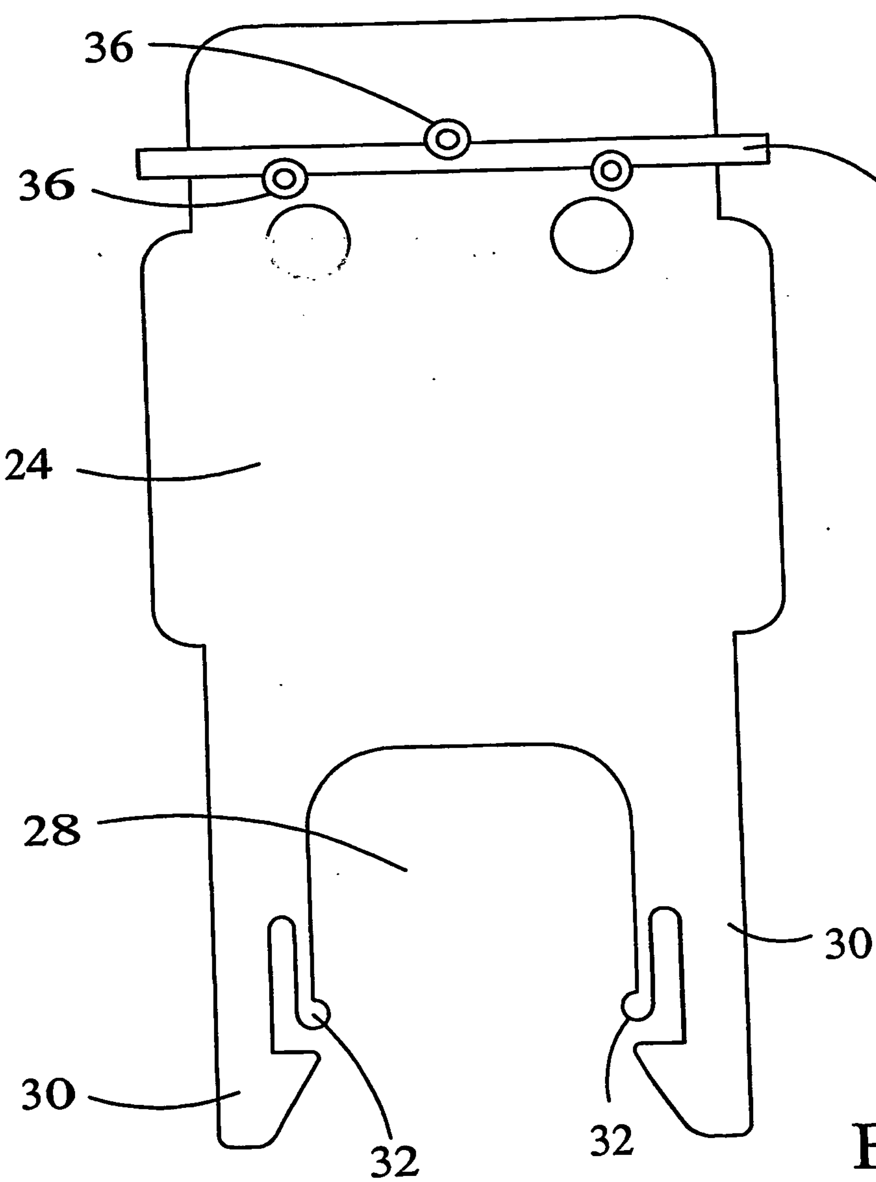

Fig 5

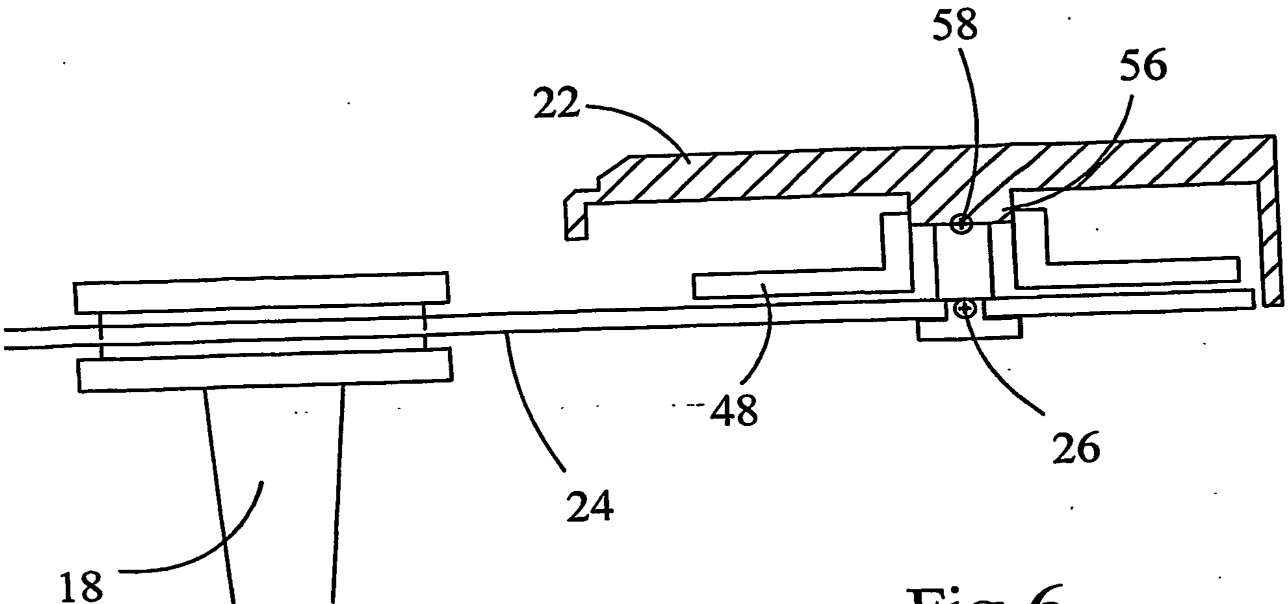

Fig 6

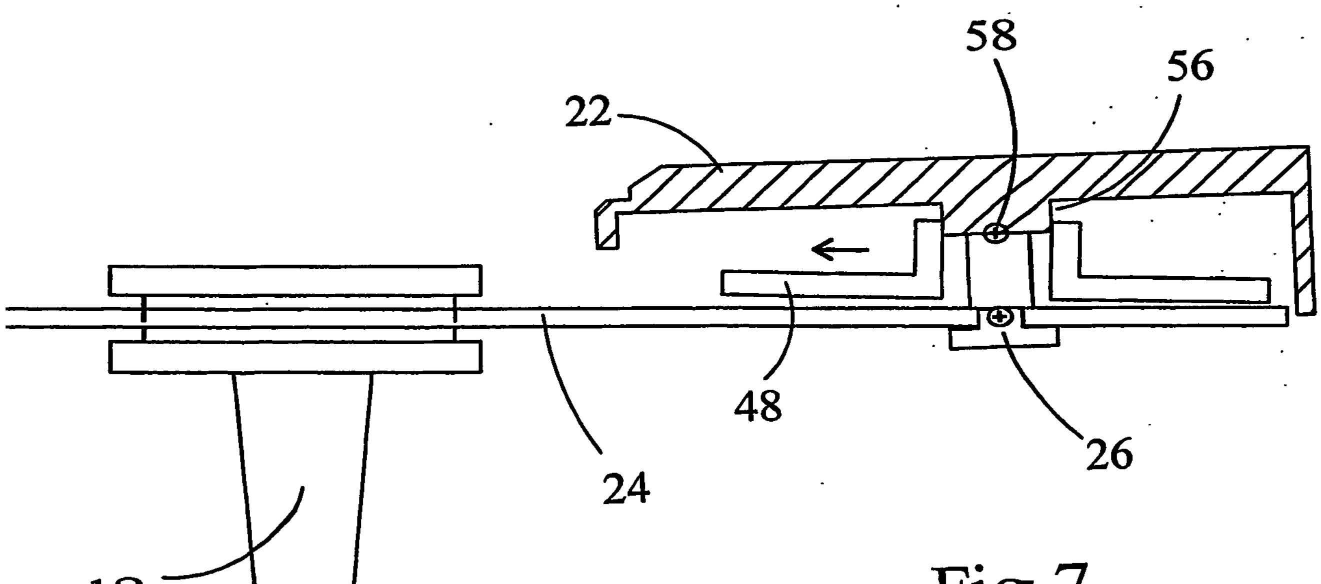

Fig 7

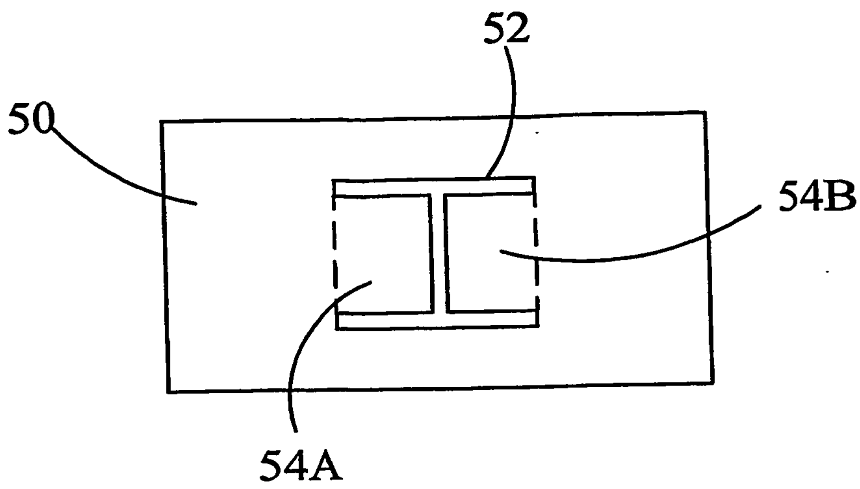

Fig 8

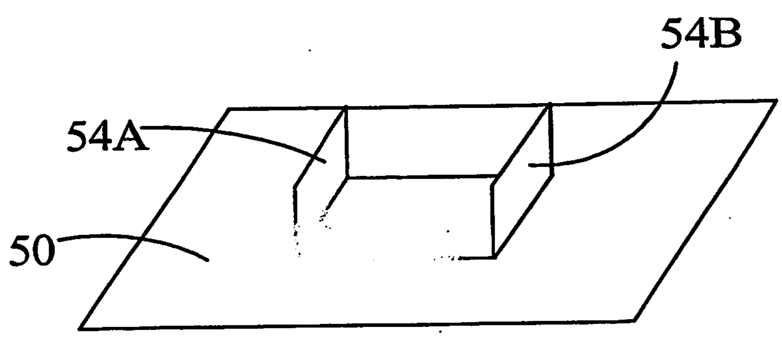

Fig 9

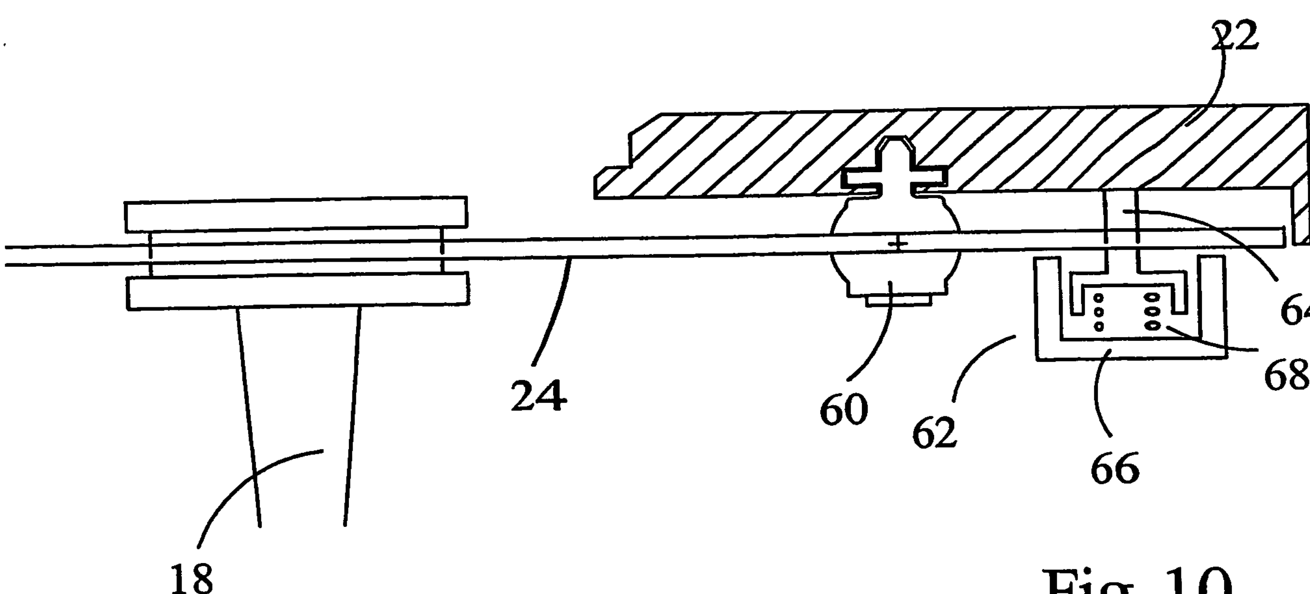

Fig 10

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